Prototype GIS Application In Delta Morphometry

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Biography

Lecturer of GIS, Harokopio University, Dept. of Geography (2002 -). Scientific area: GIS and Applied Geography. Professional experience in GIS application design, and participation in many relevant research projects focused on Geographical Applications. Main research interests: GIS applications, spatial analysis, geoinformatics, GIS – RS integration.

Introduction

River deltas are the most sensitive and complex ecosystems at the land - water interface due to many physical factors leading to their formation and evolution. They are of fundamental socioeconomic significance attracting agricultural, rural, fishing as well as tourism activities. The lack of extended plains suitable for cultivation in mountainous countries like Greece enhances the important role of the low-lying deltaic areas for economic development (Karymbalis et al, 2001). Furthermore, deltaic environments comprise significant wetlands. Deltas like other low-lying coastal areas are extremely sensitive in near future anticipated rapid sea level rise due to the melting of continental glaciers and the expansion of the oceanic water masses, the so-called steric effect, triggered by a rise in air temperature.

Delta morphometric analysis is a quantitative way to relate fluvial and marine processes to the morphology of the delta. The applied method attempted in the present paper constitutes an upgrade of the methodology proposed in the early 1970's (Wright and Coleman, 1973). The present application is a contribution in proposing delta classification including types reflecting process regimes ranging from fluvial-dominated to wave dominated deltas. In addition this method can be adapted to any delta taking into consideration individual characteristics and geomorphological irregularities.

Quantitative estimations in association with qualitative geomorphological field observations especially in the vicinity of the land water interaction coastal zone can significantly help the interpretation of the recent geomorphological evolution of the delta (Stournaras, 1999). Similarly the configuration of the deltaic coastline can be investigated quantitatively, defining retreating and prograding regions.

Method

Nowadays the main GIS software vendors have created integrated software packages to meet the need of a diverse user community (Longley et al 2001). The dominant trend is to develop systems for “general use”. Thereby, these systems do not provide specific operations for computing special delta characteristics explicitly. However Geographical Information Systems offers several utilities and analytical functions,

which might be useful in an effort to develop a prototype system for computing delta characteristics and classify deltas. Specifically a GIS provides functions for terrain modeling and analysis (DTM generation from various sources, slope calculation, generation of topographic sections) as well as for geometric and spatial statistical calculations (Chalkias and Stefanakis 2002).

This study presents an approach on delta morphometric calculations and delta classification, which applies and extends the utilities offered by a Geographical Information System. Thus, a prototype system has been developed as an outcome. This prototype takes as input the following related variables:

- Topography (elevation points and contour lines)
- Active main channel /s
- Bathymetry of the delta front (bathymetric isolines and point data)
- Delta geometric features (delta recent central axis/es, delta width axis, delta length, perpendicular to width axis) (figure 1).

The hybrid character of the system provides options either to primary input some of the data (using digitizing techniques) or to use external digital sources.
A special application has been developed to compute delta geometric features based on river geometry and other related data (geology, topography).

The main aim is to calculate significant morphometric parameters for segments of each side of the delta prominence central length axis. These segments are as following:

- Fluvial sediment volume of each segment.
- Index that expresses the skewnnes of the total sediment volume corresponding to the left and the right part of the central axis.
- Sediment distribution index for each part of the delta.
- Main slope of the subageous profile of the delta front.

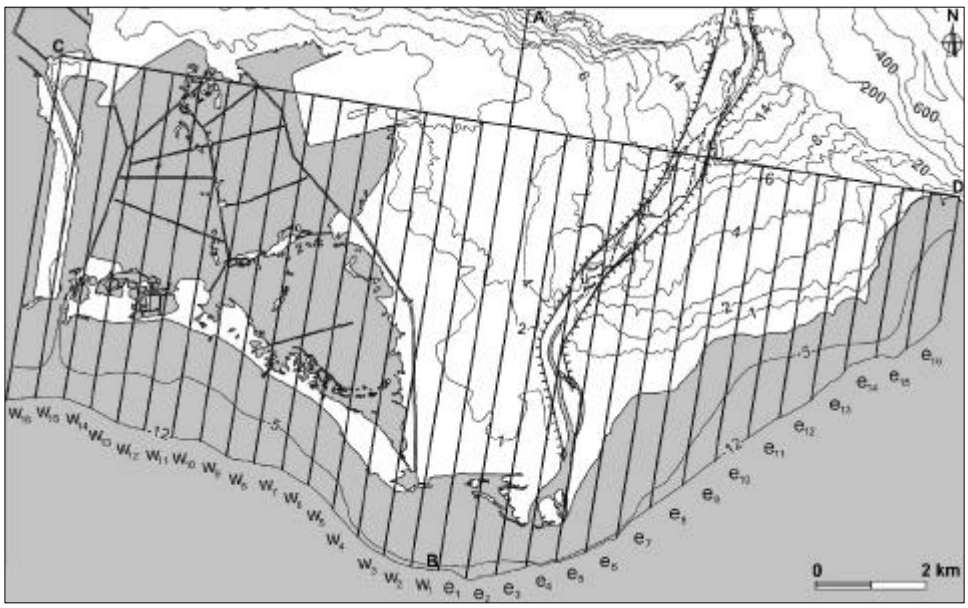

Figure1. Terms of delta morphometric analysis. CD: delta width axis, AB: delta length, e_i: east segments, w_i: west segments. Evinos delta, western Greece.

Figure 2 illustrates the architecture of the prototype. The core system consists of a commercial GIS software package (ArcGIS). This software is extended with special external functions (developed in a third generation programming language) implemented for the morphometric analysis.

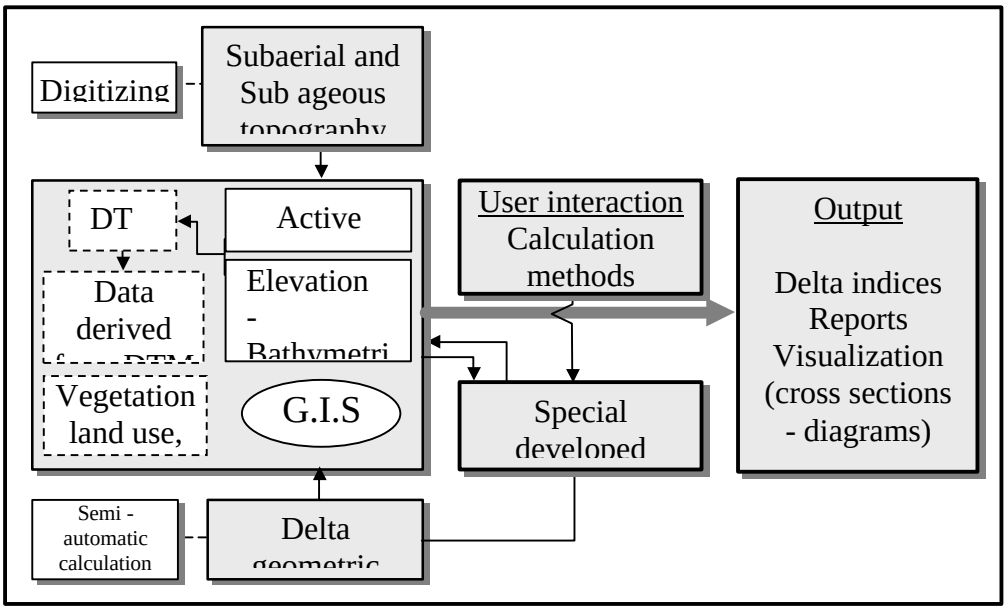

Figure 2. Architecture of the prototype system.

The Digital Terrain Model of the study region is created using appropriate data (topography, river channels) and specialized functions (ANUDEM algorithm, Hutchinson, 1989).

The user defines the following parameters:

- Delta geometric characteristics (as mentioned there is an option for semi - automatic calculation)
- Alternative calculation methods and parameters (DTM or contour line based approach, number of slices, etc)
- Type of outputs (diagrams, tables, etc)

The extensibility of the prototype ensures that special applications can also incorporated to support more processes and estimations in deltaic regions using other layers (vegetation, land use, human activities etc).

Finally, the paper will discuss the main characteristics and uses of the designed system, and the potential applications focused on delta configuration in relation to anticipated future sea level rise.

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